

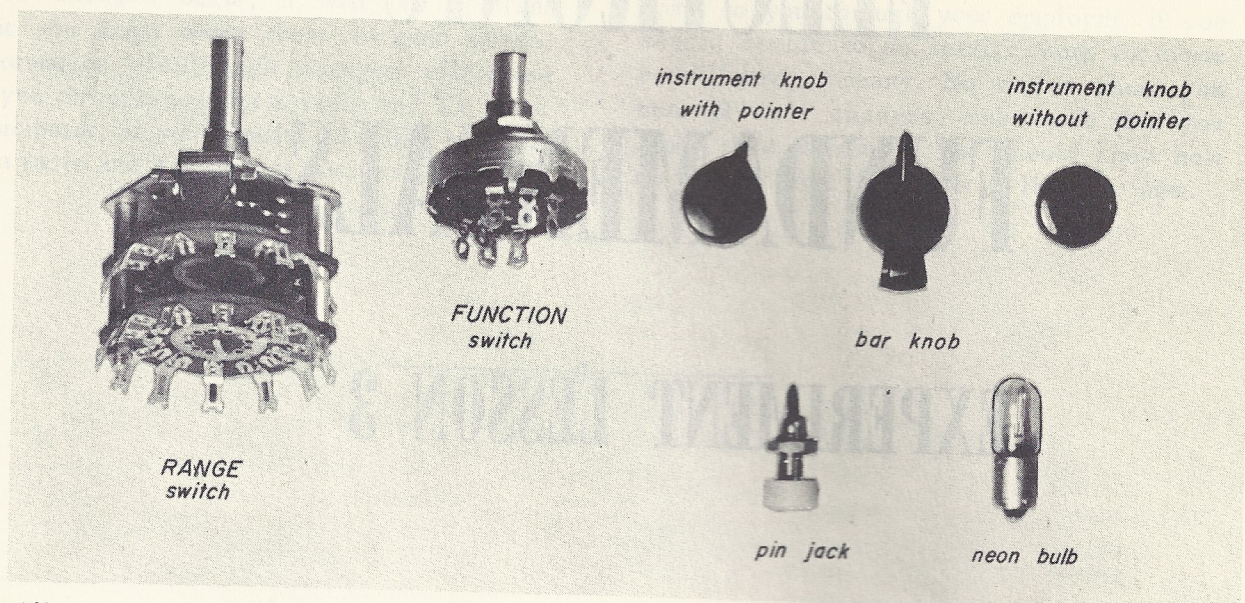
ELECTRONIC FUNDAMENTALS

EXPERIMENT LESSON 3

STARTING THE MULTIMETER ASSEMBLY



RCA INSTITUTES, INC.
A SERVICE OF RADIO CORPORATION OF AMERICA
HOME STUDY SCHOOL
350 West 4th Street, New York 14, N. Y.



All the parts in Kit 2 are listed below. Check the parts you receive against this list. Make sure you have the correct quantity of every item. If a part is either missing or defective upon arrival, request a replacement from Department R, Home Study School, RCA Institutes, Inc., 350 West 4th Street, New York 14, N.Y. *Your request must include your name and student number, the complete name and description of the part copied from the Item column below, the Quantity missing or defective, and the reason you are asking for a new part.*

KIT 2

Quantity	Item	Quantity	Item
1	Meter box	1	Pin jack, yellow plastic cap, with nut
1	Meter panel	1	Pin jack, red plastic cap, with nut
1	Switch (RANGE), 2-pole 11-position, with lockwasher, index stop, flat washer, nut	1	Pin jack, black plastic cap, with nut
1	Switch (FUNCTION), 2-pole 3-position, with lockwasher, flat washer, nut	1	Neon lamp
1	Resistor, 8 megohms, 1/2 watt, 1%	5	Red #20 solid pushback wire
1	Resistor, 1.5 megohms, 1/2 watt, 1%	5	Black #20 solid pushback wire
1	Resistor, 400 k-ohms, 1/2 watt, 1%	1	Instrument knob with pointer and set screw
1	Resistor, 80.1 k-ohms, 1/2 watt, 1%	1	Instrument knob, without pointer, with set screw
		1	Bar knob with set screw
		4	Screw, binding head, 3/8"

If you get a part slightly different from a part described in this list, the substitute part will not interfere electrically or mechanically with your experiments or equipment.

Experiment Lesson 3

OBJECT

In this lesson, you will apply the knowledge of the skill in soldering you gained in the first two Experiment Lessons by starting to wire a multimeter.

CHECK KIT

Unpack the parts in Kit 2 carefully, and check them against the illustrations and the list on Page 2.

After checking the parts, place the little neon bulb away safely where you you can find it for use in the next Experiment Lesson. To prevent the resistors from being damaged, place them back in the envelope in which they came. Then place these and the other small parts in some container, where you will find them when you need them.

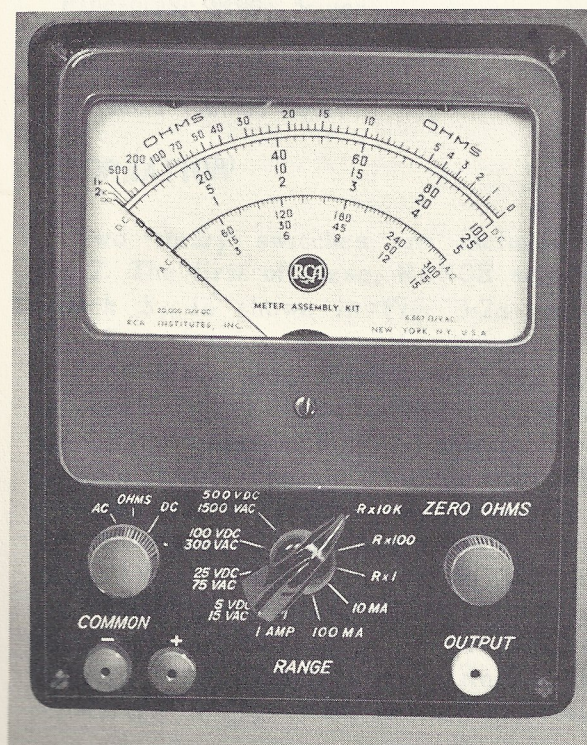


Fig. 3-1

THE MULTIMETER

The multimeter that you will assemble in this course (shown in Fig. 3-1) is like those used by engineers, laboratory technicians and top radio and television servicemen. It is a very sensitive instrument. In fact, it is the most sensitive instrument that it is practical to use both in the repair shop and on outside radio and TV service calls. If you assemble this meter carefully, it should give you many years of useful service. In other lessons, you will receive complete instructions in the use and care of your multimeter.

Because your multimeter is a first-rate instrument, and not the run-of-the-mill thing usually given to students to experiment with, you must be careful to follow all instructions given in these lessons on the assembling, wiring, and use of your meter. A great deal of thought has gone into planning the order in which you will receive the multimeter parts and the order in which you will wire these parts. To prevent you from going ahead too rapidly and to prevent you from making mistakes, the parts of the multimeter are being shipped to you in different kits and only as you need them. You may even get a little impatient to receive all the parts so that you may wire and assemble them in a hurry. However, by taking time to do a careful job, you will save money on possible meter repairs, and, what is more, you will justify our confidence in your ability to handle first-class equipment even while you are learning.

METHOD

To reduce the chance of making mistakes, to make the wiring job easier, and to make

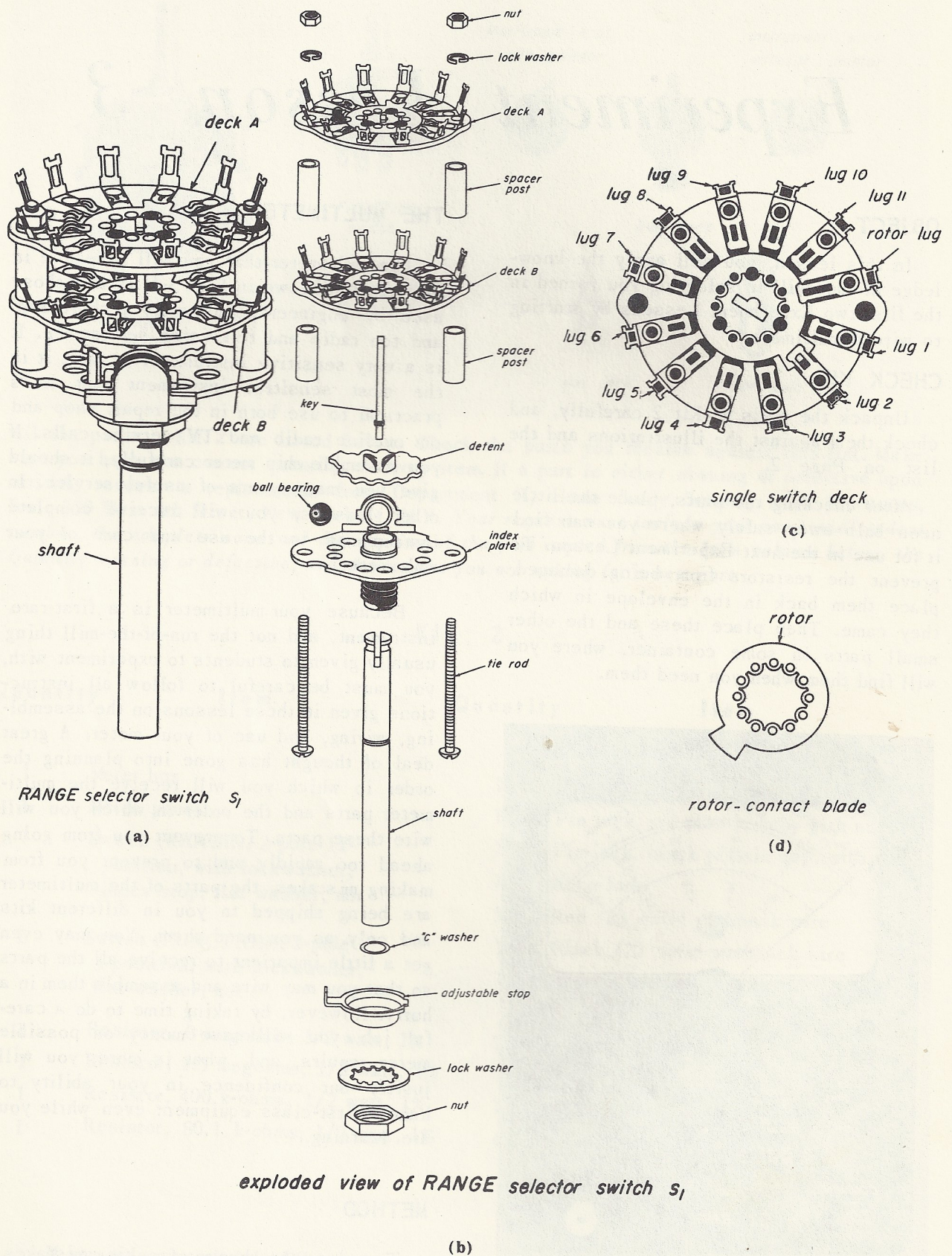


Fig. 3-2

sure that each part is placed where it belongs, the assembling and wiring of parts is laid out in several series of steps. A drawing showing the actual work to be done is given with each series of steps so that the wiring may be checked and double-checked as you go along. By doing each step of assembling and wiring in the order given, you will do a more professional looking job — one to be proud of.

EQUIPMENT NEEDED

Kit 2

Soldering iron

Cloth

Solder

Long-nose pliers

Diagonal cutting pliers

Adjustable crescent wrench or one
5/8", one 1/2", and one 9/16"
open-end, or box wrench

Fine-blade screw driver

Ruler

INFORMATION

Two rotary switches are included in Kit 2. The first of these, RANGE selector switch S_1 , is shown in Fig. 3-2a and b. The first drawing shows the switch as it actually is; the second shows what is called an *exploded view* of the same switch, showing the parts that make up the switch. If you examine it, you can see that the switch is made up of two layers of contacts, placed one above the other. Each of these layers is called a *deck* or *wafer*. Looking at Fig. 3-2c, you can see that each wafer has twelve contact lugs, mounted in a circle around a movable metal ring. This metal ring, shown separately in Fig. 3-2d, is called a *rotor*,

because it rotates or turns around as the shaft turns. You will notice that the rotor has a tab, or contact blade, that makes contact, one at a time, with each of the contact lugs, numbered from one to eleven. The remaining contact lug extends farther out toward the center and makes contact with the rotor ring in all switch positions. For this reason, it is called a *rotor contact lug*. This deck, therefore, is known as a single-pole, eleven-position deck, and the entire switch is known as a two-pole, eleven-position switch. The decks are identified in Fig. 3-2a by the letters A and B.

The FUNCTION switch, S_2 , shown as it actually looks in Fig. 3-3a and in an exploded view in Fig. 3-3b, is a two-pole, three-position switch. Select this switch from the parts in Kit 2 and examine it closely. You will find that all you can see is a shaft, a switch cover, and a wafer with eight lugs. What happens inside the switch is hidden from your view. By examining the exploded view of Fig. 3-3b, you can see how this switch is put together. Fig. 3-3c shows the hidden side of the switch wafer. You can see two groups of contacts, one marked A and the other B. Each of these groups is made up of three numbered contacts; each contact is part of the lug marked with the same number. Connected to each rotor lug is the metal rotor plate with finger-like projections spread out between the numbered contacts. Switching is done by rotating the shaft, which is connected to an insulating wafer upon which are mounted rotor shoes — one for each group of contacts. As shown in Fig. 3-3d, as the shaft rotates, each rotor shoe makes connection, between its rotor plate and one of the numbered contacts. So each group of contacts, together with its rotary contact, makes up a single-pole, three-position switch, and the two groups and their rotary contacts unite to form a two-pole, three-position switch. *Do not attempt to take this switch apart to examine it.* If you do, you may break the insulating wafer or find it very difficult to reassemble the switch properly.

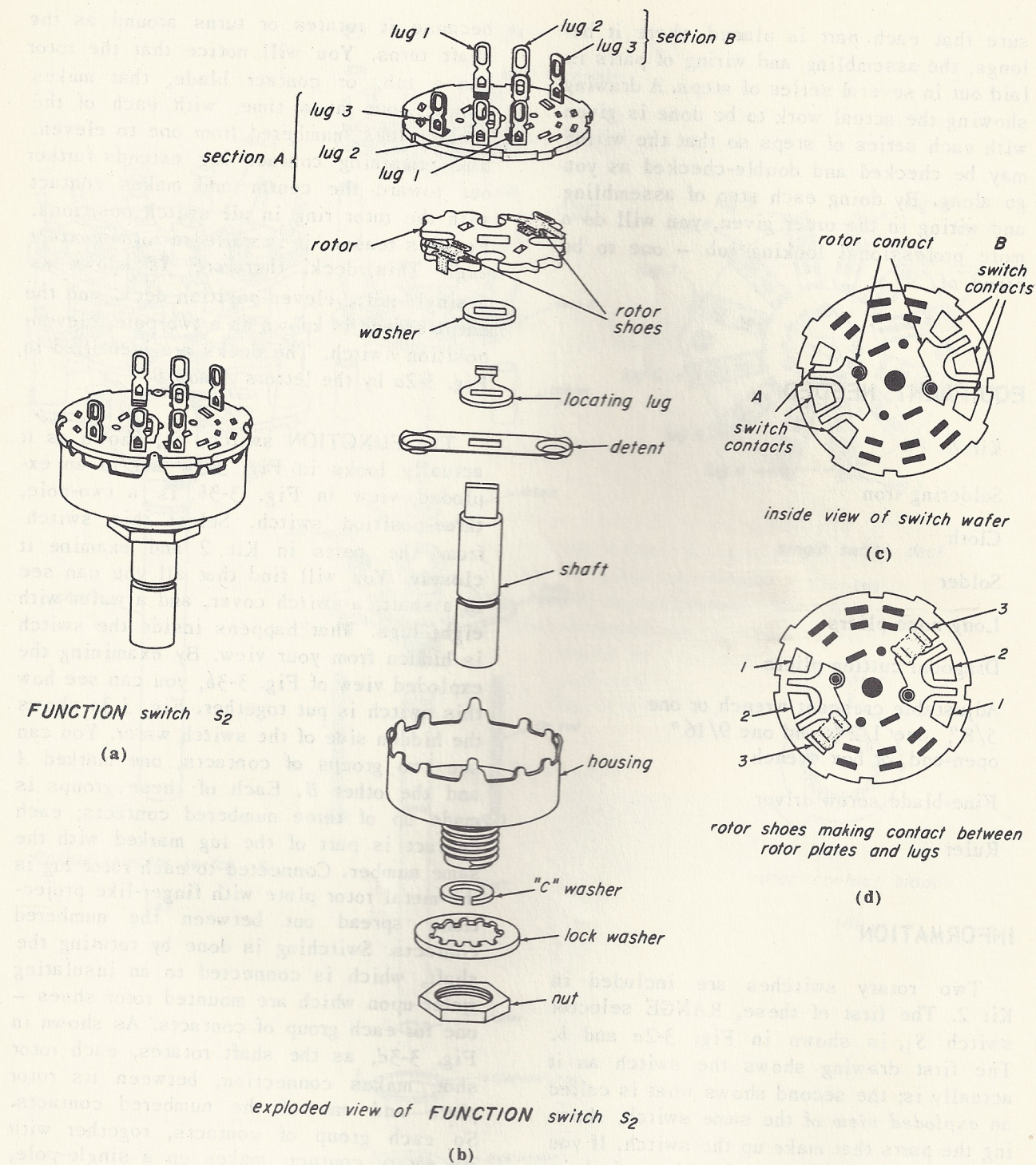


Fig. 3-3

PREPARATION

1. Before mounting or wiring any parts, check the photograph that is shown in Fig. 3-4. It shows how the parts received in Kit 2 are assembled. See how they look when

they are mounted and wired according to the instructions that follow. In other words, get some idea of what you are going to do before you do it.

2. Prepare your bench or table for work,

with tools and the parts from Kit 2 laid out for work.

3. Be sure that your soldering iron is clean and tinned, ready to be heated and used.

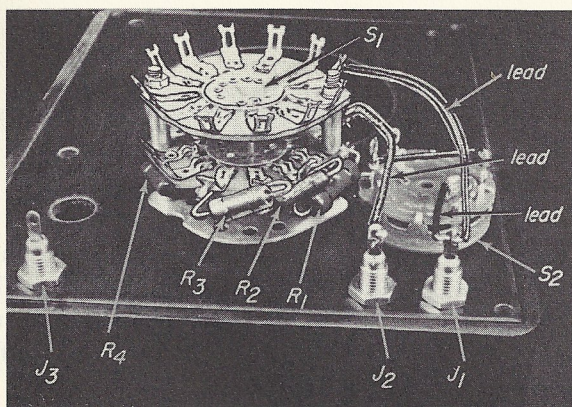


Fig. 3-4

JOB 3-1

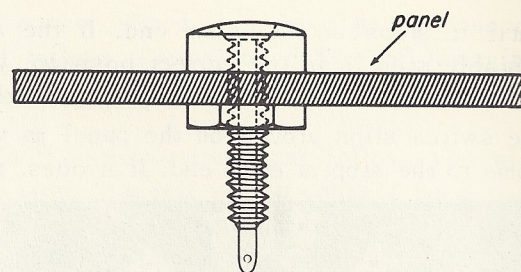
To mount the three colored pin jacks as shown in Fig. 3-5 *a* and *b*.

Procedure.

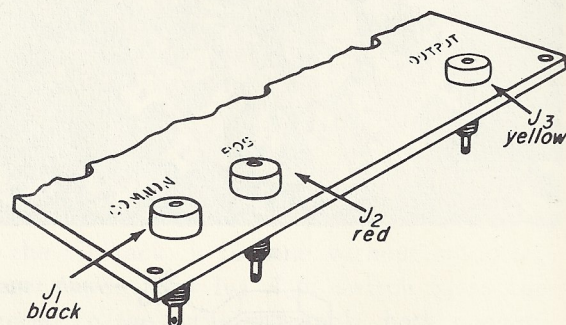
Step 1. Mount black pin jack J_1 . To do this, place the threaded shaft of the jack through the hole, as shown in the picture diagram, and tighten in position with one of the jack mounting nuts, using a 3/8 inch wrench or a crescent wrench. If you haven't either of these tools, you may use adjustable combination pliers (gas pliers). In fact, you may use them wherever a wrench is called for in these instructions. However, if possible, avoid the use of these adjustable pliers, as they tend to bite into the nuts and leave them misshapen. When properly mounted, the black insulation of the pin jack should face you as you look at the front of the cover panel.

Step 2. Mount red pin jack J_2 in the same way. Be sure that it is in the position shown in Fig. 3-5.

Step 3. Mount yellow pin jack J_3 in the same way in the remaining pin jack hole, as shown in Fig. 3-5.



(a)



(b)

Fig. 3-5

JOB 3-2

To mount RANGE selector switch S_1 exactly as shown in Fig. 3-6a.

Procedure.

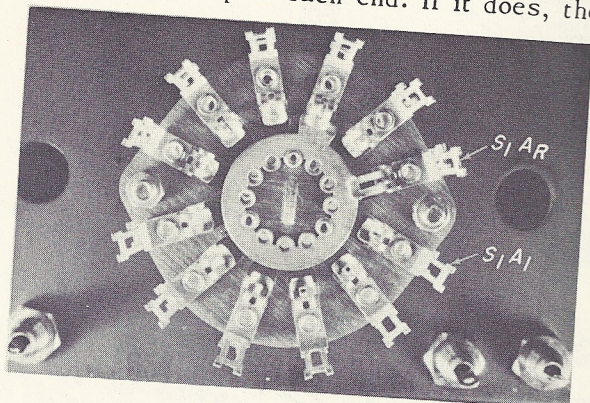
Step 1. Be sure that the rotor lugs are in the position shown (see position of S_{1AR} in Fig. 3-6a) and that the *adjustable stop* is in the proper hole, as shown in Fig. 3-6b, before pushing the shaft in the hole in the panel.

Step 2. Place a lock washer over the threaded shaft. Insert the shaft in the hole. On top, place a flat washer over the shaft. Fasten in place with a 9/16-inch nut.

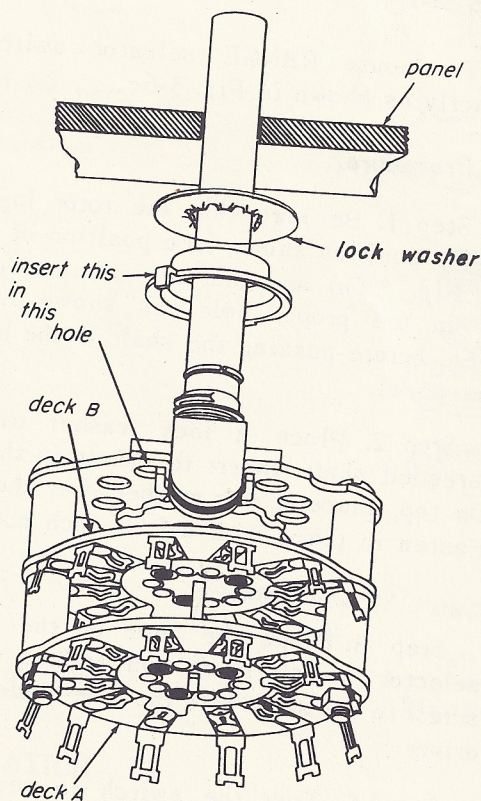
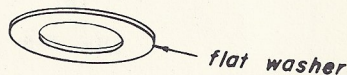
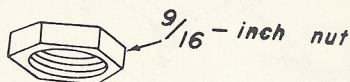
Step 3. Place the knob on the RANGE selector switch shaft and tighten the set screw to the shaft with the fine-blade screwdriver.

Step 4. Test the switch to see if the adjustable stop is in the correct position. To do this, turn the switch knob in a clockwise direction until it stops. Then, as you turn the knob in a counterclockwise direction, count the number of clicks the rotor makes

until it stops at the other end. If the adjustable stop is in the correct position, you should hear nine clicks. Note, too, whether the switch slips around on the panel as you come to the stop at each end. If it does, the



(a)



Detail of mounting switch S_1
on meter panel

(b)

Fig. 3-6

nut on the switch shaft needs further tightening.

Step 5. Turn the switch to its extreme counterclockwise position. Unscrew the knob. Line up the knob pointer with the RX10K line. Tighten the screw on the knob.

JOB 3-3

To mount FUNCTION switch S_2 with its lugs in the position shown in Fig. 3-7.

Procedure

Step 1. Slip a lock washer over the threaded part of the shaft. Push the FUNCTION switch shaft through the proper hole in the panel. Place a flat washer over the shaft and fasten in place with a 1/2-inch nut.

Step 2. Place the small pointer knob on the switch shaft. Tighten the set screw. Turn the knob all the way clockwise. Line up the knob pointer with the DC line and tighten the set screw to the shaft with your fine-blade screwdriver.

Step 3. Turn the knob counterclockwise until it stops. Then turn it in the opposite direction. You should hear the second click as it comes to a stop.

Step 4. Place the meter box on a bench or a table and place the cover panel upside down on the four corner mounting posts in the box, as shown in Fig. 3-8. In this way, the meter box acts as a convenient support for your work. It prevents scratching or otherwise damaging the face of the cover panel. (In radio and electronics factories, supporting

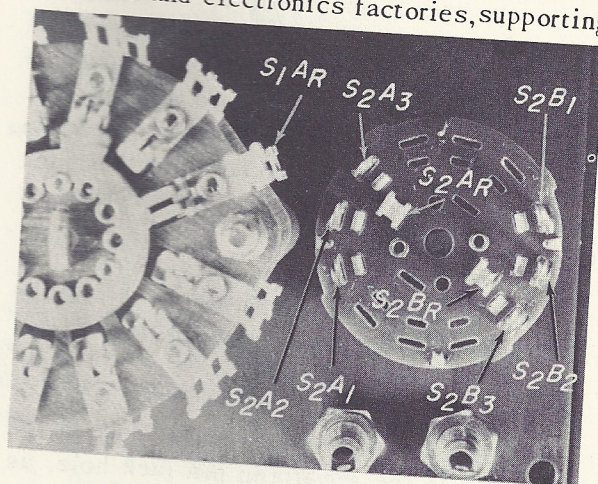


Fig. 3-7

clamps or box forms, called *jigs*, are used to hold a radio or other chassis in position for easy work.) Your meter box, therefore, becomes a jig to keep your meter panel and mounted parts steady while you work on them.

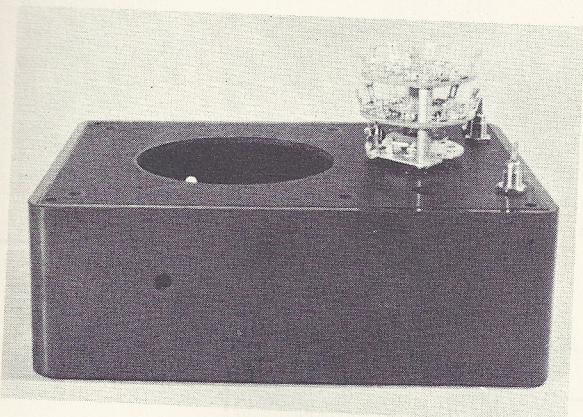


Fig. 3-8

JOB 3-4

To mount the first resistor, R_1 , on Switch S_1 .

Information. In the following steps, the actual wiring begins. At this point, it would be a good idea for you to check your soldering iron and connect it to your electric outlet so that it will be ready for use when you need it. While your soldering iron is heating, turn back to Fig. 3-4, and see the wiring that you are actually going to do in this lesson.

Doing a neat, accurate job of wiring, such as is shown in the picture, calls for good soldering. Use no more solder than is necessary to make a good joint. You can readily see that using too much solder on the switch lugs, for example, may cause them to touch each other. This might easily cause damage to your meter the first time you use it. Whenever, in the following steps, you connect a resistor or a wire to one of the switch lugs, make very, very sure that the resistor or wire is connected to the proper lug. To help you do this, each switch lug is numbered in all drawings, and each switch jack or section is lettered. With a little care, you can avoid making errors. Remember that

you cannot afford to make a wrong connection without risking the danger of damaging the meter movement.

In the instructions that follow, you will find some that tell you to connect some part or lead to a particular terminal. This means that a good tight connection should be made *without soldering*. The reason for this is that, in wiring this meter, sometimes two, three, or even more leads are connected to the same terminal or lug. Therefore soldering is not done until the last connection is made.* For example, if you look at Fig. 3-4, you will find that two leads are connected to pin jack J_1 . So, when the connection is made between the rotor lug B of switch S_2 to the pin jack, it is done without soldering. Later, when rotor lug A of switch S_1 is connected to the same pin jack, both connections are soldered at the same time. In some cases, the instructions tell you to solder a lead or resistor to a certain lug. This means that you must first make a good tight connection and then solder it.

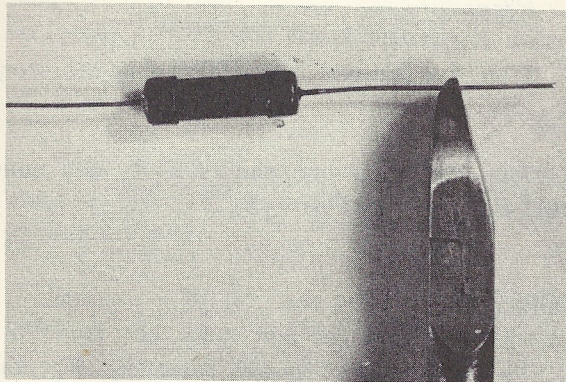
You may find that some of the resistor leads are dull from oxidation or dirty from handling, even though they are tinned. If so, before connecting and soldering them, clean them lightly with fine sandpaper.

The wiring you will do in this lesson is shown in schematic form in Fig. 3-9. After you are familiar with such circuits, it will be possible, sometimes, to make connections and to do wiring without further information. However, to be on the safe side, it is better to follow the step-by-step directions that follow.

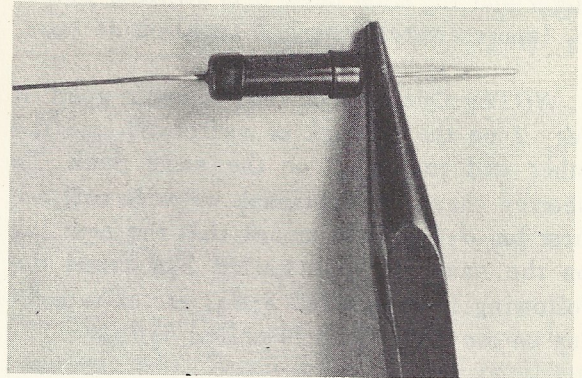
Procedure.

Step 1. Prepare the 8-megohm resistor, R_1 , by removing one-half inch of wire from each end with your diagonal cutting pliers, as shown in Fig. 3-10a.

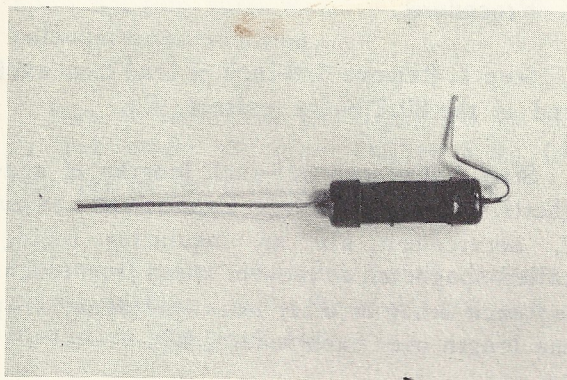
*You may remember that, in the two soldering lessons, you were told to solder each connection as you went along — to make sure none were forgotten. This advice is still good for most wiring. However, in these instructions, you will be reminded to solder any connection that you are told to connect, so there is no danger of your forgetting.



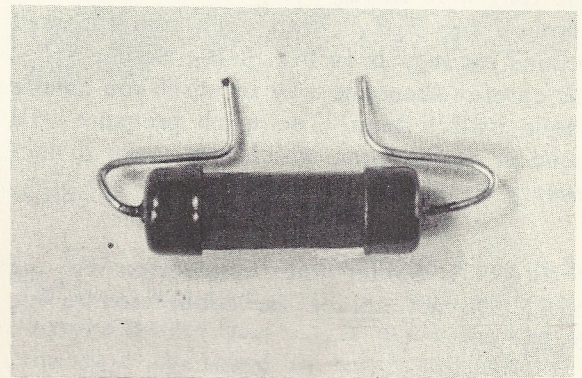
(a)



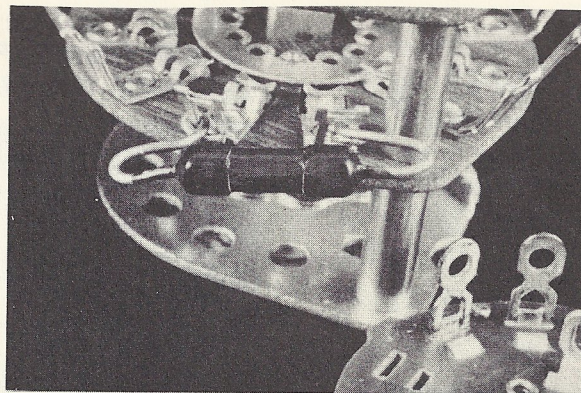
(b)



(c)



(d)



(e)

Fig. 3-10

Step 2. If necessary, clean the resistor leads lightly with fine sandpaper. Do not remove the tinning.

Step 3. Place one of the resistor leads between the jaws of your longnose pliers, as shown in Fig. 3-10b. Then bend the lead into the shape shown in Fig. 3-10c. Be sure to bend the lead and not the body of the

resistor. By holding the lead with the pliers, you are prevented from making too short a bend, and, consequently, from breaking the lead off from the resistor. Next, place the pliers at the other end and bend the lead in the same way. When this work has been done, the resistor will look as it does in Fig. 3-10d. The distance between the leads should then be the same as the distance between

lug 1 and lug 2 on deck B of RANGE switch S_1 (approximately one-half inch).

NOTE: One end of this resistor goes to lug 1 on the B deck of switch S_1 and the other end to lug 2 on the same deck. To shorten these instructions, we will call the first lug S_1B_1 . This means that the next lug on the same deck is called S_1B_2 , and the following lug is called S_1B_3 , etc. The rotor lug on the same deck is called S_1B_R .

Step 4. Slip one lead resistor R_1 through the long hole in lug S_1B_1 and the other lead through lug S_1B_2 . Wrap each resistor lead around its lug, as in Fig. 3-10e. Solder S_1B_1 . Be careful about the way in which you handle these switch lugs. Too much pressure will bend or break them, which may make it necessary to replace the switch.

Step 5. Solder the connection to lug S_1B_1 . Do not solder the connection to lug S_1B_2 yet.

JOB 3-5

To mount the second resistor, R_2 , on switch S_1 . In the last procedure, each step was given in exact detail because it was the first time you were going through these operations. It is not necessary to repeat all these instructions for the next few steps because the work is done the same way in each case.

Procedure.

Step 1. Prepare the 1.5-megohm resistor, R_2 , as you did R_1 .

Step 2. Solder one end to S_1B_2 . Connect the other end to S_1B_3 .

JOB 3-6

To mount the third resistor, R_3 , on switch S_1 .

Procedure.

Step 1. Prepare the 400 k-ohm resistor, R_3 , as before.

Step 2. Solder one end to S_1B_3 and connect the other end to S_1B_4 .

JOB 3-7

To mount the fourth resistor, R_4 , on Switch S_1 .

Procedure.

Step 1. Remove 5/8-inch of lead from each end of the 80.1 k-ohm resistor, R_4 .

Step 2. Cut two 5/8-inch lengths of spaghetti. (As you know from Experiment Lesson 2, servicemen use an insulating tubing, called spaghetti, to prevent wires from touching each other or other metal surfaces.) Slip one length over each lead of R_4 .

Step 3. Solder one end of R_4 to S_1B_4 and connect the other end to S_1B_7 , as shown in Fig. 3-11. Be sure to keep the body of the resistor below the 5th and 6th lugs on the same deck, because in another lesson you will connect other resistors to these lugs. Also be sure that no part of the bare resistor lead touches the spacer post between the 6th and 7th lugs.

JOB 3-8

To make the connections between the red

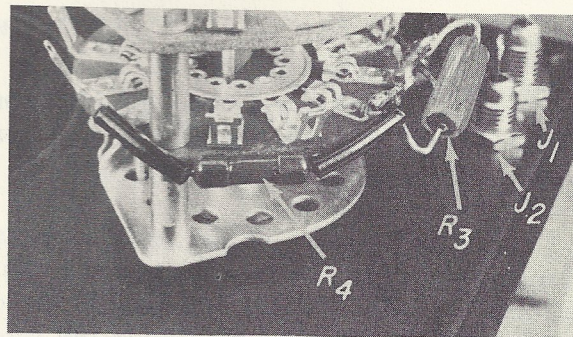


Fig. 3-11

and black pin jacks and the RANGE selector switch and the FUNCTION switch.

Procedure.

Step 1. Cut a 1-1/2-inch length of solid hook-up wire. Remove 1/4-inch of insulation from each end.

Step 2. Solder one end to S_2B_R and connect the other end to the black pin jack J_1 , as shown in Fig. 3-12.

Step 3. Cut one 2-1/2-inch length of solid hook-up wire. Remove 1/4 inch of insulation from each end.

Step 4. Solder one end to the red pin jack J_2 and solder the other end to S_1B_R (the rotor lug on the B deck on Switch S_1).

Step 5. Cut one 2-3/4-inch length of solid hook-up wire. Remove 1/4-inch of insulation from each end.

Step 6. Solder one end to the black pin jack, J_1 , and solder the other end to S_1A_R .

Note: Make sure that neither wire nor solder from either of these rotor connections

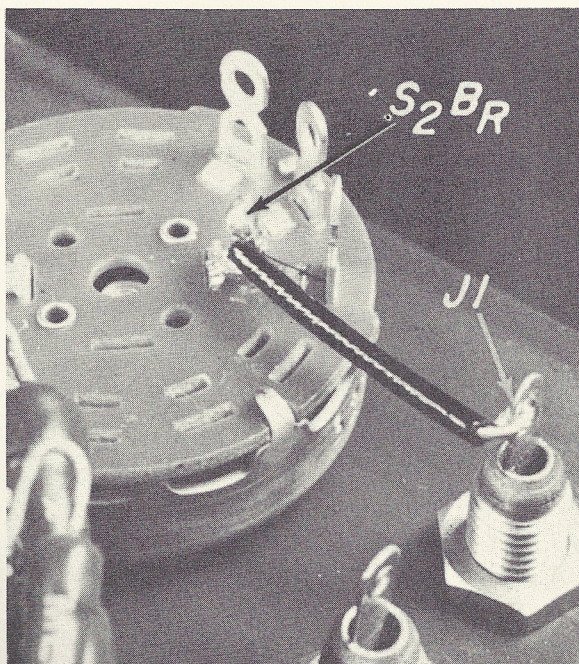


Fig. 3-12

on S_1 touches the metal post and the screw next to the rotor lugs.

JOB 3-9

To connect S_2A_1 to S_2B_1 .

Procedure.

Step 1. Cut one 1-3/4-inch length of hook-up wire. Remove 1/4 inch of insulation from each end.

Step 2. Solder one end to S_2A_1 and solder the other end to S_2B_1 , as shown in Fig. 3-13.

CHECK YOUR WORK

With this last connection, you have finished the first part of your multimeter wiring. Before you put it aside to wait for the parts included in Kit 3, examine your work carefully. Make the following checks:

1. See if the resistors you have connected to the RANGE switch S_1 are of the values called for by the instructions.
2. Make sure that the resistors and wires are connected to the lugs called for in the wiring instructions.
3. Make sure that no bare wire touches any other bare wire or metal surface, except

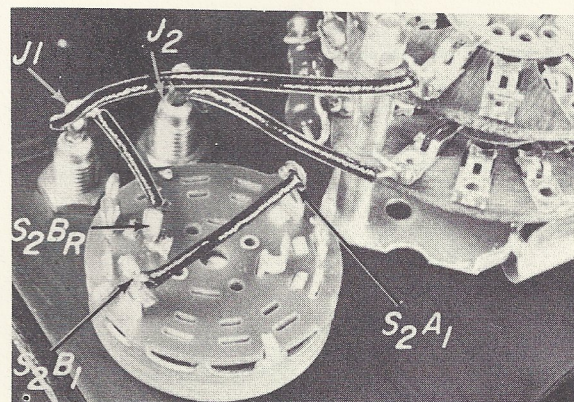


Fig. 3-13

where the instructions call for wires to be connected to the same lug.

4. Be sure that the soldering is well done, without cold solder joints or excess solder.

5. When you are satisfied that your work

is done correctly and well, place the meter panel on the meter box so that the switches and resistors are inside and the front of the panel faces up. Carefully place your partly constructed meter away, where it will be safe until you need it next. It is a good idea to cover the meter so that dust and dirt do not get between the switch contacts.

